REMARKS

Claims 1, 2, and 4-22 are present in this application. Claim 3 has been canceled. Claim 22 has been added. Claims 2, 8-21 have been withdrawn.

Of the examined claims 1 and 3-7, claim 1 is an independent claim.

Claim Rejection under 35 U.S.C. 103(a) – Jacquet, Ishikawa, Giacomelli

Claims 1 and 3-7 have been rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 5,283,799 in view of JP 02-137383 (Ishikawa) and Giacomelli. Applicants respectfully traverse this rejection.

Summary of the Present Invention

The present invention pertains to improvements in semiconductor laser devices for enhanced reading from high-density recording medium ("Description of the Background Art"). In such an environment, some light is reflected from a surface of the recording medium and returned to the laser, which is referred to as "feedback light." The returned feedback light and light emitted from the laser interfere with each other, resulting in noise ("feedback-induced-noise"). (Specification at page 1, lines 25-30). An effective method for reducing this noise is to periodically change the intensity of an optical output in order to reduce the coherency of the semiconductor laser ("modulated optical output"; Specification at paragraph bridging pages 1-2).

The present application discloses several approaches to producing a modulated optical output using a semiconductor laser, including "self pulsation," "high-frequency superimposition method," and bistable semiconductor laser (Figs. 15-17).

Applicants have found that a problem with the bistable semiconductor laser has been that in order to reduce feedback light, it is necessary to apply a voltage or current of large amplitude

to adjust the lasing threshold of the laser and thereby produce a modulated optical output (Specification at page 11, lines 10-19). Furthermore, when producing the modulated optical output, it is likely that the saturable absorber region saturates, resulting in an optical output having a small amplitude and a lack of pulsed optical output (Specification at page 11, lines 20-25). In order to increase the optical output necessary for a pickup device of a recording medium, the lasing threshold of the laser would need to be switched with a wide range for producing a high optical output (Specification at page 12, lines 15-22).

Thus, the present invention is directed to a semiconductor laser device having low power consumption and reduced feedback-induced noise ("Summary of the Invention").

Embodiments of the present invention covered by claim 1 are directed to a semiconductor laser reducing feedback-induced noise by an optical output modulated to arise stochastic resonance, comprising:

an active layer having a light-amplifying region (e.g., 3) and a saturable absorber region (e.g. 4) formed to allow said semiconductor laser to be in a bistable state;

an electrode of a first polarity (e.g., p electrodes 1, 2); and

an electrode of a second polarity (e.g., n electrodes 3, 4) provided in relation to said electrode of the first polarity, wherein

at least one of said electrode of the first polarity and said electrode of the second polarity is divided to allow a current to be injected independently into said light-amplifying region and said saturable absorber region (e.g., Fig. 1), wherein hysteresis is controlled to adjust the lasing threshold of the laser (Specification at page 23, lines 9-13), wherein

said current (Fig. 2C) is generated by superimposing a noise current (Fig. 2B) on a modulation current (Fig. 2A), and

the intensity of said modulation current and the intensity of said noise current are adjusted with respect to each other so as to allow said modulated optical output to have a large amplitude and achieve an effect of reducing the feedback-induced noise (Specification at paragraph bridging pages 22-23).

In particular, the present invention is an arrangement in which a modulation current which is small to the degree that transition to the upper hysteresis path is impossible can be injected to produce an optical output with a large amplitude (specification at page 23, lines 20-23). This is accomplished by controlling the intensity of the additional noise to a level that it has an effect of reducing feedback-induced-noise.

According to the present specification, the transition point between the lower hysteresis path to the upper hysteresis path is enabled by stochastically synchronizing the maximum value of the modulation current and a change in intensity of the additional noise (specification at paragraph bridging pages 22-23; and page 23, second full paragraph).

JP 02-137383

Applicants have determined that the bistable semiconductor laser of JP02-137383 would require a voltage or current of a large amplitude to be applied in order to produce an optical output of a large amplitude that would be sufficient to reduce feedback light (specification at page 11, second paragraph).

Giacomelli

Giacomelli is interested in improving the quality of the transmission, which has been defined in terms of a correlation between the input signals and the output signals. The figure

cited in the Abstract shows the middle trace superposed with the output trace. The Abstract states that an improvement of the quality of the output signal is observed as the amount of noise is increased, up to an optimal value. In other words, Giacomelli defines quality in terms of the correlation between the input and output signals.

In particular, Giacomelli applies the concept of "stochastic resonance" in an effort to obtain the improved quality of transmission. Giacomelli's experimental setup is a Vertical Cavity Surface Emitting Laser (VCSEL), a polarizer, and a detection device (according to the other papers, a photodiode). The laser input current is produced from the summation of a variable intensity, white-noise generator and a pseudo-random binary sequence generator.

Differences over Jacquet, Ishikawa, and Giacomelli

The Office Action admits that Jacquet does not teach the claimed controlling the hysteresis to adjust the lasing threshold, or an output as a modulated stochastic resonance. Furthermore, the Office Action admits that Jacquet and Ishikawa do not disclose driving the device using a modulated signal with a superimposed noise current. Instead, the Office Action alleges that Giacomelli teaches a method for operating a laser diode wherein a modulated current signal is superimposed with a noise current having a random intensity change used to drive the device.

Applicants submit that none of the cited references address the problem of "feedback-induced-noise."

Applicants submit that the stochastic resonance of Giacomelli would not solve the deficiency of JP 02-137383 of requiring a large amount of power to overcome the problem of "feedback-induced-noise," which was disclosed in the present application. In particular, the

stochastic resonance of Giacomelli would not reduce the amount of power required to adjust the lasing threshold in the laser of JP 02-137383.

An improvement made in the present invention over JP 02-137383 that enables reduction in the lasing threshold, is the adjusting of the noise signal until it is stochastically synchronized with the maximum value of the modulated current (i.e., to give a signal that is of the form as shown in Fig. 2C). In order to clarify this distinguishing feature, claim 1 has been amended claim 1 to include the feature that "the intensity of said modulation current and the intensity of said noise current are adjusted with respect to each other so as to allow said modulated optical output to have a large amplitude and achieve an effect of reducing the feedback-induced noise." Applicants submit that Jacquet, Ishikawa, and Giacomelli, either alone or together, fail to teach at least this claimed feature in the context claimed.

For at least these reasons, Applicants submit that the rejection fails to establish *prima facie* obviousness. Accordingly, Applicants request that the rejection be withdrawn.

Further with respect to claim 4, the Office Action merely alleges that a rectangular wave is a type of sinusoidal wave, and thus would have been an obvious variation. Applicants disagree. No evidence has been presented to support this allegation.

To the contrary, Applicants have determined that a rectangular wave will result in a capability of increasing the amplitude of the optical output, producing a sharper pulse waveform, with a lower input current. Furthermore, a wider range of additional noise intensity can be achieved (specification at page 25, first paragraph at page 26, lines 20-23).

For at least this additional reason, Applicants submit that the rejection fails to establish *prima facie* obviousness for claim 4.

New Claim

A new dependent claim that covers the feature that hysteresis is controlled by adjusting the noise current until it is stochastically synchronized with the maximum value of the modulated current. Applicants submit that Giacomelli teaches only setting the noise signal at various levels.

CONCLUSION

In view of the above amendment, applicant believes the pending application is in condition for allowance.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Robert Downs Reg. No. 48,222 at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37.C.F.R. §§1.16 or 1.14; particularly, extension of time fees.

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Respectfully submitted,

By Robt C. Downs #48,222

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